Technology Development and Commercialization

Olivine Phosphate Composite Cathodes

ANL-IN-11-024, “Lithium Iron Phosphate Composites for Lithium Batteries”,

Technology Marketing Summary

This invention comprises a family of lithium iron composite materials with unique electrochemical features that enable the high energy and power performance of olivine cathodes without the use of carbon coatings. The materials in this invention have excellent rate capability when used as the active material in a Li-ion Battery. More specifically, the present invention describes the synthesis and characterization of composite materials that include $LiFePO_4$ for use in, but not limited to, electrode materials for lithium-ion batteries. The materials have been made, characterized and fully tested.

Description

The active cathode material used in a battery for transportation applications requires high power and capacity, long cycle and calendar life, excellent safety characteristics including thermal stability, and low cost and toxicity. Current commercial electrode materials have difficulties providing all of these desired performance characteristics, and thus research has been conducted to search for new materials that can meet the demands of lithium-ion batteries for transportation applications.

The cathode of a lithium-ion battery is a composite of particles that reversibly intercalate lithium ions held together in a matrix by a polymeric binder. Typically, there are also carbon additives that improve the conductivity of the cathode. The most common commercial cathode material is $LiCoO_2$, although $LiMn_2O_4$ and $LiFePO_4$ are also produced in commercial quantities. One of the major drawbacks of $LiCoO_2$ is the relatively high cost and toxicity of cobalt, which makes this material challenging to implement in large scale transportation applications. $LiFePO_4$ is a promising cobalt-free alternative for the cathode in batteries for transportation applications. $LiFePO_4$ has an olivine structure, reversible capacities of up to ~160 mA-h/g, high coloumbic and energy efficiency, and a charge/discharge voltage of ~3.5 V (resulting in a total reversible energy storage of ~560 W-h/kg). Pure $LiFePO_4$ has poor conductivity and thus problems with cycling at reasonable or high charge/discharge rates, however, nanosized carbon-coated $LiFePO_4$ has much improved rate capability and conductivity. This invention describes a composite material which has $LiFePO_4$ as the principle component, where the rate capability of the material is drastically increased without a carbon coating. Electrochemical evidence is provided of at least one additional phase in the composite which enhances the performance of the electrode material.

Benefits

- Significant increase in both energy density and cycle lifetime
- No carbon coating is needed saving a processing step and reducing current costs by a possible 50%
- The addition of a material is very low cost and does not change the current cathode manufacturing process
- The manufacturing process is considered scalable

Applications and Industries

- Transportation applications, such as electric and plug-in hybrid electric vehicles
- Portable electronic devices, such as cell phones and laptop computers
- Medical devices
- Space, aeronautical, and defense-related devices

Developmental Stage

Reduced to practice

Availability

Available for licensing

Intellectual Property Status

ANL-IN-11-024, “Lithium Iron Titanium Phosphate Composites for Lithium Batteries”,
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